the feasibility of the EBT3, a comparison was made with the PDD determined by means of the ionization chamber. For this purpose, the chamber was irradiated at different depths in the solid water phantom (range between 0 mm and 30 mm).
Results: A HVL of 0,87 mm Aluminium (Al) was obtained for the 3cm applicator. The in-air measurements with the ionization chamber provide an absorbed dose to water at the surface of 0,92 Gy/min. The calibration curves for the EBT3 GC film in the green and red color channel is presented in figure 1 (top). The best fit between the optical density and dose is a fifth degree polynomial fit. The PDD curves obtained with the ionization chamber and EBT3 are shown in figure 1 (middle and bottom). The curves are normalized to the surface (0 mm) and show a very rapid dose fall-off with depth. Films exposed parallel to the beam axis show good agreement with the ionization chamber between 4 mm and 13mm. At the surface, EBT3 has lower doses and at depths beyond 13 mm the GC film has a higher response compared with the ionization chamber measurements. Films exposed perpendicular to the beam axis give higher doses in comparison with the ionization chamber over the whole range of depths, except for 10 mm depth. Although, all measuring points (parallel and perpendicular) agreed within 5% beyond 3 mm depth.

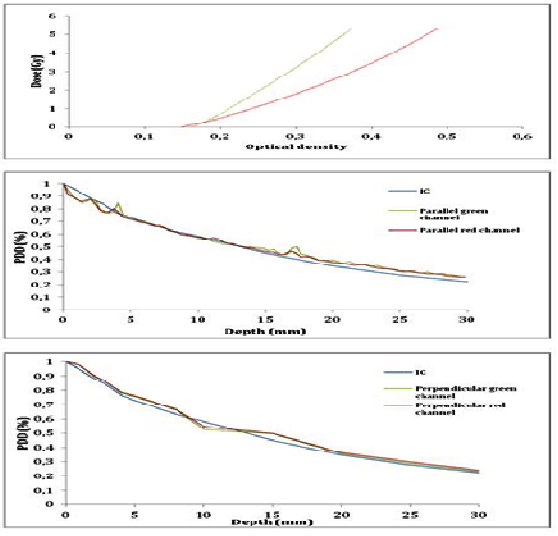

Figure 1: Calibration curves of EBT3 for the green and red color channel (top), PDD curves for EBT3 films exposed parallel (middle) and perpendicular (bottom) to the beam axis

Conclusions: Good agreement (max 5% difference) was found between ionization chamber and EBT3 GC film. This study showed that EBT3 GC film is a feasible option for absolute and relative dosimetry of a 50 kV X-ray system. Furthermore,the film can be exposed parallel and perpendicular to the beam axis.

EP-1156
Calibration frequency of an ìin-vivoî dosimetric device for dose verification during dynamic plan treatment
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Purpose/Objective: Each treatment plan which use dynamic methods for inpatient dose distribution is routinely verified before first treatment session. Unfortunately, this pre-treatment method is not fully sufficient in terms of necessary information for physicians of correct daily dose delivery. The aim of this study was to analyze the behavior of the new in-vivo dosimetric device DAVID (PTW Freiburg, Germany) in accordance to the calibrations factors of the device.
Materials and Methods: The advanced device is designed for each specific accelerator and depend on number of leafs installed in MLC. It consists of very thin translucent multi-wires ionization chambers which are parallel to the leaf direction of movement. It is attached to the collimator of the gantry for all treatment fields. After some clinical implementation tests it was observed that not all errors could be easily explained. During the study the frequency of calibration process was evaluated. The default period time is set to 8 hours. The calibration was performed each 0.5 hour, then each 2 hours, once per day and only once per week. For each group the calibration was performed 10 times for all 80 chambers. The reference dose was each time measured in water phantom using cylindrical ionization chamber and renormalized to 1Gy, calibration factors were recalculated. In all groups for each chamber the mean, standard deviation and maximum deviation between calibration factors were calculated. Changes of calibration factors were estimated and observed.
Results: The median value and standard deviation for the maximum difference of calibration factors in 0.5 hour time period was 0.20%±0.22%, in 2 hours group it was 0.74%±0.30%, once per day it was 1.13%±1.47% and for once per week 0.65%±1.20%. The largest deviations were for once per day calibration group which is correlated with beam output changes between next few days. The measurements for that group were performed during 2 working weeks.The highest deviation was observed between calibration done at Friday and at Monday after the weekend. It was observed that for first and last wire chambers the deviations were much larger (up to 12%) than for other chambers. It occurred for calibrations which were done on 2 similar machines and was generated by device holder misalignment.
Conclusions: The dosimetric system is a good tool for daily real-time dose delivery verification. However, it should be carefully calibrated. The default calibration time period can be freely adjusted. It does not have to be done more frequently. It can be carried out once per week. In next step of the study it will be analyzed if once per week calibration is sufficient and gives reliable final results of patients measurements. Using the device on similar accelerators without dose recalibration it is necessary to verify device holder alignment.

EP-1157
Verification of MLC motion during VMAT delivery by use of an in-house program
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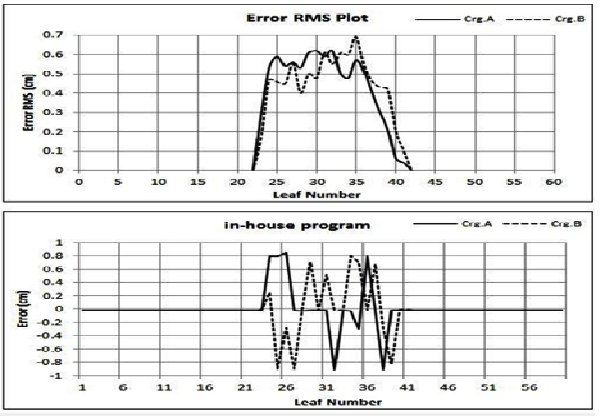
Purpose/Objective: The purpose of our study is to verify the accuracy of Multi-leaf Collimator (MLC) motion during Volumetric Modulated Radiation Therapy (VMAT) delivery by use of an in-house program.
Materials and Methods: We developed an in-house program for evaluating the MLC motion by use of the MLC-log during VMAT delivery. The program has been built by Visual Basic Ver.6.0 (Microsoft Corporation, USA). The MLC-log during VMAT delivery was exported to our program from the Clinec 21EX linear accelerator equipped with the Millenium MLC (Varian, USA) after VMAT delivery. As a fundamental evaluation, the basic MLC motion during VMAT delivery was verified via our program in comparison with specific program for root-mean-square analysis (Dynalog File Viewer (DFV): Varian, USA). The collimator angle was fixed at 0 degree. The MLC moved from B-side to A-side of carriage box. As clinical evaluations, the MLC-logs of some VMAT plans for Head&Neck and prostate patients were verified by use of our program and DFV.
Results: As results of the fundamental evaluation, the maximum error of MLC motion with our program was larger than that with DFV program. The errors of MLC motion with our program were similar to those with DFV program. This means that our program has a potential to evaluate MLC-log exactly as well as DFV. The errors became large when MLCs were pulled on A-side and/or pushed on B-side. When a simple sweeping motion was perfomed, the errors were observed less than 0.1 mm. As the results of the clinical evaluation, the maximum and mean errors were calculated. For prostate cases, the maximum error by use of our program and DFV were 0.90 mm and 0.69 mm, respectively. For Head&Neck cases, the maximum errors by use of our program and DFV were 0.89 mm and 0.75 mm, respectively. These errors were both momentary errors and ineffective for clinical prescription dose. In addition, MLC motion error of Head&Neck case were larger than those of prostate case As a result of detailed analysis in clinical evaluation, almost errors were not continuous but large momentary errors. However these errors were acceptable because of these ineffective values.



Conclusions: We think our program is able to detect large momentary MLC errors during VMAT delivery even if DFV can't detect these errors. In addition, our program provides many users ease for quality assurance of MLC because our program can visualize the MLC motion during VMAT delivery.

EP-1158

In-phantom measurements of accelerated partial irradiation and arc-therapy for breast cancer

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Purpose/Objective: The aim of this study is to evaluate the performance of the treatment planning algorithm in the determination of dose distributions for non-standard breast cancer treatments (arctherapy and Accelerated Partial Breast Irradiation –APBI-), by means of in-phantom TLD dosimetry.

Materials and Methods: TLD-100 chips were used to determine the absorbed dose at different points in the surface an anthropomorphic female thorax phantom, as well as at the center of the simulated tumor, inside the lung and at the interface between lung (polystyrene foam, ρ_e=0.19 e/cm^3) and tissue (mixture of glycerin and gelatin, ρ_e=1.125 e/cm^3). Dose measurements were compared to the results obtained with the TPS XiO® V4.62 using the FFT convolution algorithm. The APBI treatment included 6 beams of 6 MV, four of which were non-coplanar with a mean field size of about 4x4 cm^2. The arc treatment was performed using 6 beams of 6 MV and one of 15 MV beams, 2 of them were arcs. Both treatments were planned using forward planning.

Results: It was found that tumor dose measurements, for arctherapy exhibited a mean variation of 5% under the TPS values and of 13% for the APBI case. In both treatments the dose at the surface was consistently overestimated by the algorithm, 6% in the arctherapy case and 18% for the APBI treatment. Lung measurements presented larger deviations in both techniques.

Conclusions: Arctherapy measurements, in general, agreed better with the calculated results. This was expected considering the higher complexity of the APBI technique. The relatively large deviations observed for the tumor can be explained by the reduced size of the phantom's breast, which made difficult to locate the detectors under equilibrium conditions and far from high dose gradients. There was a marked trend of TPS overestimation of the dose in tissue interphases, consistent with the absence of epithelitis in patients treated with these techniques.

EP-1159

BELdART-2: a national IMRT audit

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Purpose/Objective: Past incidents in radiotherapy centers both in Belgium and in surrounding countries have shown the need for an extensive quality audit program in radiotherapy. In Belgium these audits were first commissioned by the Federal Agency for Nuclear Control (FANC) and performed as a voluntary national audit (BELdART). It was the first national audit program using L-α-alanine-EMR dosimetry at such large scale. All Belgian radiotherapy departments participated in the BELdART dosimetry audit over a period of 3 years (2009 – 2011). In total 34 centers and 61 linacs were audited and were confirmed to work within optimal levels. At the end of 2012 the College of Medicine - Radiotherapy gave the permission to start with a national mailed audit program involving more complex radiation therapy techniques.

Materials and Methods: All clinical radiation units in Belgium (> 91) will be audited in a period of 4 years using 2 independent dosimetric techniques. The audit is designed for more complex treatment techniques, i.e. IMRT, arc therapy, Tomotherapy, Ciberknife, …. Absolute measurements will be performed using L-α-alanine-EMR dosimetry and EBT3 film dosimetry will be used for the measurement of 2D dose distributions. Irradiations will be performed at the hospital centers and the local physicists will perform both planning and delivery. The 'easy-cube' (sun nuclear) will be used as phantom and custom made slabs preloaded with the alanine pellets and gafchromic films will be inserted for the different steps in the QA protocol to limit the amount of manipulation involved in the process and reduce the user-dependent uncertainty. Beside checks of the treatment delivery in homogeneous and inhomogeneous setting an extra check where the electron density reconstructed by the treatment planning will be compared to the known values of the easy cube.

Results: The first round of auditing for basic conditions have shown that it was possible with alanine to reach an accuracy similar to the golden standard ionization chamber with an uncertainty of 1% (k=1) for doses down to 4 Gy. Preliminary audits will be performed in cooperation with university hospitals in Belgium to assess the realistic achievable quality of IMRT implementation in Belgium.

Conclusions: In view of the development of new techniques of radiation dose delivery that brings new difficulties even at the level of reference dosimetry, auditing programs using completely independent dosimeters are of the utmost importance to insure safe and high quality treatments at the national level.

EP-1160

Absolute dosimetry with EBT2: double channel calibration and empirical crossplane correction.

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Purpose/Objective: The aim of this work is to present a method; developed in our hospital, that allows using Gafchromic EBT2 films to perform absolute dosimetry.

Materials and Methods: The method consists of two parts: the first one is to perform a dosimetry calibration and the second to apply a correction to remove the transverse dependence of the scanner. Dosimetry calibration is done following the steps outlined in the paper by A. Micke et al.[(1)] concerning the dual channel calibration (DCC) for Gafchromic EBT2 films irradiated at different dose levels ?? in a Siemens ARTISTE linac and digitized in transmission mode 24 hours after irradiation using an Epson Expression 10000XL scanner. Each film is digitized three times placing it in the center of the scanner with landscape orientation and active layer down. In each digital image RGB channels are splitted using ImageJ software. Pixel value (PV) is converted into optical density (OD) for the red (ODr) and blue (ODb) channels. A new image is obtained dividing the ODr image (ODrI) by ODbI. This process is done with an ImageJ plug-in developed by the authors of this work. Dose (D) readings are made with PTW 0.6 cc ionization chamber (IC), placed in a RW3 slabs phantom. Obtaining the average value ODr/ODbin a ROI centered on each image the calibration table {ODr/ODb, D} is generated. Transverse correction is obtained digitizing the pieces of film used in the DCC. Pieces are placed at different lateral positions along the center of the scanner and 112 images are obtained (14 positions x 8 dose levels). Red channel is splitted from each image and a set of 112 readouts is generated getting the PVr from 1x1 cmxcm centered ROI's normalized to that of the center of the scanner. Correction factor, f(x, D) is obtained as a function of the lateral position (x) and D.

Results: It is noted that dose dependence of the correction factor is negligible thus a new factor is calculated based on the average: f (x). Plotting f(x) versus x (# pixel), three differentiated regions are observed (Fig 1).